REMARKS/ARGUMENTS

Claims 1-19 were presented and examined. The Examiner objected to the drawings, the title of the invention, certain grammatical/typographical errors in the specification and abstract, and certain grammatical/typographical errors in the claims. The Examiner rejected claims 1-19 under 35 USC § 103(a) as being unpatentable over Sharangpani et al. (USPN 5,860,017) in view of Maki (USPN 5,729,707). In this response, Applicant has submitted proposed replacement drawing sheets, amended the specification including the title of the invention and the abstract, amended claims 1, 3, 4, 7-9, 11, and 12, canceled claims 5 and 14-19, and added new claims 20-22. Claims 1-4, 6-13, and 20-22 are now pending.

Amendments to the Drawings

Applicant has submitted a proposed set of four drawings sheets to replace the originally submitted drawing sheets. FIG 4 has been amended to include reference numerals 400, 402 and 404, which were included in the specification but inadvertently omitted from the originally submitted drawings. Applicant thanks the Examiner for catching this error.

The Examiner also requested that a PRIOR ART designation be included on FIGs 1-3. Applicant has amended FIG 3 to include the PRIOR ART designation, but Applicant would respectfully submit that FIGs 1 and 2 do not depict prior art. FIG 5 illustrates selected details of a branch prediction unit 206 according to the present invention. FIG 2 illustrates selected elements of a microprocessor 101 that includes branch prediction unit 206. FIG 1 illustrates selected elements of a data processing system 100 that includes microprocessor 101. Thus, FIG 1 and FIG 2, both include the branch prediction unit that is illustrated in FIG 5 and therefore illustrate more than that which is old. Consistent with the requirement under 37 CFR 1.84(p)(4) requiring that reference numerals be used consistently throughout the different drawings, Applicant would respectfully submit that FIG 1 and FIG 2 are not prior art because they both include the novel branch prediction unit 206. Accordingly, Applicant requests the Examiner to reconsider and withdraw the objections to FIG 1 and FIG 2 and to withdraw the objections to FIG 3 and FIG 4 based on the proposed drawing amendments.

Amendments to the Specification

The Examiner objected to certain grammatical/typographical errors in the specification. In response, Applicant has amended the specification along the lines helpfully suggested by the Examiner. Applicant wishes to thank the Examiner for diligently reviewing the specification and identifying these errors. Applicant submits that the specification as amended addresses the objections raised by the Examiner and Applicant would respectfully request the Examiner to reconsider and withdraw the objection.

The Examiner objected to the length of the abstract and Applicant has amended to comply with the 150 word limit. The Examiner objected to the title and suggested a replacement title. Applicant has substantially adopted the title proposed by the Examiner. Applicant's amended title does not include the words "Compiler Generated" because the broadest claims do not recite the compiler generated limitation.

Claim Objections

The Examiner objected to certain matters of form in claims 8, 9, and 15-19. In response, Applicant has amended each of the objected-to claims along the lines helpfully suggested by the Examiner except as to claims 15-19, which have been canceled. Applicant submits that the claims as amended address the objections raised by the Examiner and Applicant would respectfully request the Examiner to reconsider and withdraw the objection.

Claim rejections under 35 USC § 103(a)

The Examiner rejected claims 1-19 under 35 USC § 103(a) as being unpatentable over Sharangpani in view of Maki. In response to this rejection, Applicant has canceled claims 14-19 and amended independent claims 1 and 7 to include a limitation wherein branch instruction information embedded in the instruction is interpreted and wherein the branch instruction information indicates the likelihood of successfully predicting the branch. Support for this amendment is found in the specification, for example, in the description of instruction 400 in the paragraph beginning on page 10, line 13.

The cited references do not disclose or suggest all of the limitations of independent claims 1 and 7 as amended herein. Neither Sharangpani nor Maki disclose or suggest the use of information, embedded within the instruction, that indicates the likelihood of successfully predicting the branch. Sharangpani discloses determining the likelihood of successfully predicting a branch by referring to performing and tracking branch prediction with a conventional branch prediction unit. In other words, Sharangpani discloses the use of special purpose logic within the processor to perform branch prediction and to determine when branch prediction is unlikely to be accurate. See Sharangpani column 7, line 10 through column 8, line 46. Sharangpani contains no teaching, suggestion, or mechanism for embedding information into the instruction that indicates the likelihood of successively predicting the branch.

Maki discloses that an instruction may include a branch prediction bit and that the branch prediction bit may be prepared by a compiler. The branch prediction bit of Maki does not contain the same information as the branch prediction information as recited in the amended independent claims. The branch prediction bit of Maki, as its name suggests, gives a prediction of the result of the branch prediction. The Maki branch prediction bit gives no indication of likelihood that the prediction will be correct. It is this "likelihood" information that is explicitly recited in the amended independent claims as being embedded with the branch instruction.

There is no suggestion to embed likelihood information in a branch instruction because Sharangpani does not suggest that likelihood information can be determined apart from historical data collected at run time and Maki does not suggest that likelihood information may be beneficial. Sharangpani teaches that the likelihood information may be determined by evaluating the percentage of previous predictions associated with a particular branch instruction that have been accurate. While this approach may be useful, the present invention beneficially recognizes that, in some contexts, the likelihood information may be determined a priori. When this is the case, the use of embedded likelihood information enables the present invention to bypass any predication unit logic and proceed directly to an instruction fetch cycle when the embedded likelihood information has an appropriate value.

Maki contains no teaching or suggestion to modify its embedded prediction bit to include embedded likelihood information because Maki does not suggest the value of likelihood

information as a tool for avoiding misprediction penalties. Maki is concerned with ensuring that prefetching continues when a branch instruction is encountered. According to Maki, conventional instruction prefetching units stop upon detecting a branch instruction (see Maki, column 2, lines 36-46). Maki is concerned with maintaining the operation of the prefetch unit and, to that end, it teaches the use of a branch prediction bit to determine the instruction address from which to prefetch instructions following a branch instruction. For purposes of maintaining the prefetch unit, which is the objective of Maki, it does not matter whether the particular branch instruction is difficult to predict. In other words, for purposes of maintaining continuous instruction prefetching, it is only necessary to supply *an* instruction address. While Maki does describe a mechanism for modifying the prediction when a misprediction occurs, nowhere does Maki teach or suggest that knowledge of likelihood information would beneficially facilitate better instruction prefetching. In fact, Maki teaches that, for embodiments in which the instructions lack a branch prediction bit, it suffices to simply use a random number generator to predict the branch (see column 10 lines 18-29). Thus, for purposes of maintaining the prefetching unit in operation, Maki teaches that simply guessing at the outcome of the branch instruction is a sufficient mechanism. Accordingly, Maki does not suggest any benefit to likelihood information and therefore does not suggest modifying Sharangpani to incorporate embedded likelihood information (compiler generated or not) into an instruction.

Because there is no motivation to combine or modify the references to arrive at the claimed combination, Applicant would respectfully submit that it would be inappropriate to apply the Section 103(a) rejection of the previously presented independent claims to the independent claims as amended herein. Accordingly, Applicant would request the Examiner to reconsider and withdraw the rejection of the amended independent claims and all claims dependent thereon.

In addition to the foregoing, Applicant has amended claim 4 to recite a quantitative assessment of when the likelihood of correct prediction justifies dual branch processing. Support for this amendment is found in the specification at page 9, line 6. The cited references neither disclose nor suggest any quantitative determination of when dual branch processing is justified

and, therefore, Applicant would submit that claim 4 as amended herein recites matter neither taught nor suggested by the cited references.

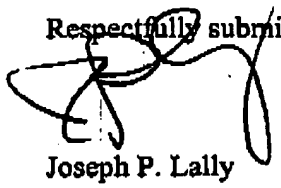
In addition to the foregoing, Applicant has amended claim 8 to recite an embodiment in which branch prediction, including branch history information, is invoked if the embedded branch instruction information indicates that the likelihood of accurate branch prediction is high while a prediction bypass unit is accessed when the embedded information indicates that the likelihood of accurate branch prediction is low. Support for this claim as amended is found in the specification at page 10, lines 6-11. The limitations of claim 8 are neither taught nor suggested by the cited references because claim 8 contemplates traditional branch prediction when the embedded information indicates a likelihood of successful prediction and dual branch processing when the embedded information indicates a low likelihood of prediction. In contrast, because Sharangpani does not describe embedded branch prediction at all, Sharangpani teaches that traditional branch prediction is always used and that dual fork processing is invoked only if traditional branch prediction data suggests a low likelihood of accurate prediction. Maki, on the other hand, teaches that, if there is branch prediction information embedded in the instruction, it is not necessary to perform conventional branch prediction at all (compare the embodiment of Maki described with respect to FIG 6 with the embodiment described with respect to FIG 8 and FIG 10). Thus, the two references combined fail to suggest and, in fact, teach away from the concept of using conventional branch prediction (including instruction history information, etc) when the likelihood of successful prediction is high and using dual fork processing when branch instruction information embedded in the instruction indicates that successful branch prediction is unlikely.

In addition to the foregoing, Applicant has introduced claims 21 and 22 directed at a compiler that embeds branch prediction information, indicative of the likelihood of successfully predicting the branch, into the branch instruction. Support for these claims is found in the specification, for example, at page 8, lines 17-23; page 10, lines 2-4; and page 10 lines 19-26. The cited references fail to disclose or suggest a compiler configured to generate branch prediction likelihood information and embed the information into a branch instruction. Sharangpani does not discuss compiler generated branch prediction information at all. Maki

indicates merely that a conventional branch prediction bit (i.e., a bit indicating which way a branch will go as opposed to information indicating the likelihood of successful prediction) may be generated at compile time. Because Maki does not motivate one to extend the concept of branch prediction to incorporate likelihood information as argued above, there is no suggestion or motivation to combine Sharangpani and Maki to arrive at the claimed combination. Accordingly, Applicant would respectfully request the Examiner to indicate the allowability of the new claims over the cited references.

In the present response, Applicant has responded to the Examiner's objections to the drawings, specification (including the title and abstract), and claims, and to the claim rejections under 35 USC § 103(a). Accordingly, Applicant believes that this response constitutes a complete response to each of the issues raised in the office action. In light of the amendments made herein and the accompanying remarks, Applicant believes that the pending claims are in condition for allowance. Accordingly, Applicant would request the Examiner to withdraw the rejections, allow the pending claims, and advance the application to issue. If the Examiner has any questions, comments, or suggestions, the undersigned attorney would welcome and encourage a telephone conference at 512.428.9872.

Respectfully submitted,



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JPL/mmm

Attachments

Annotated Sheet Showing Changes

Applicant: Kahle and Moore
Docket: AT9-99-445
Sheet 1 of 4
Contact J. Lally 512/428-9870

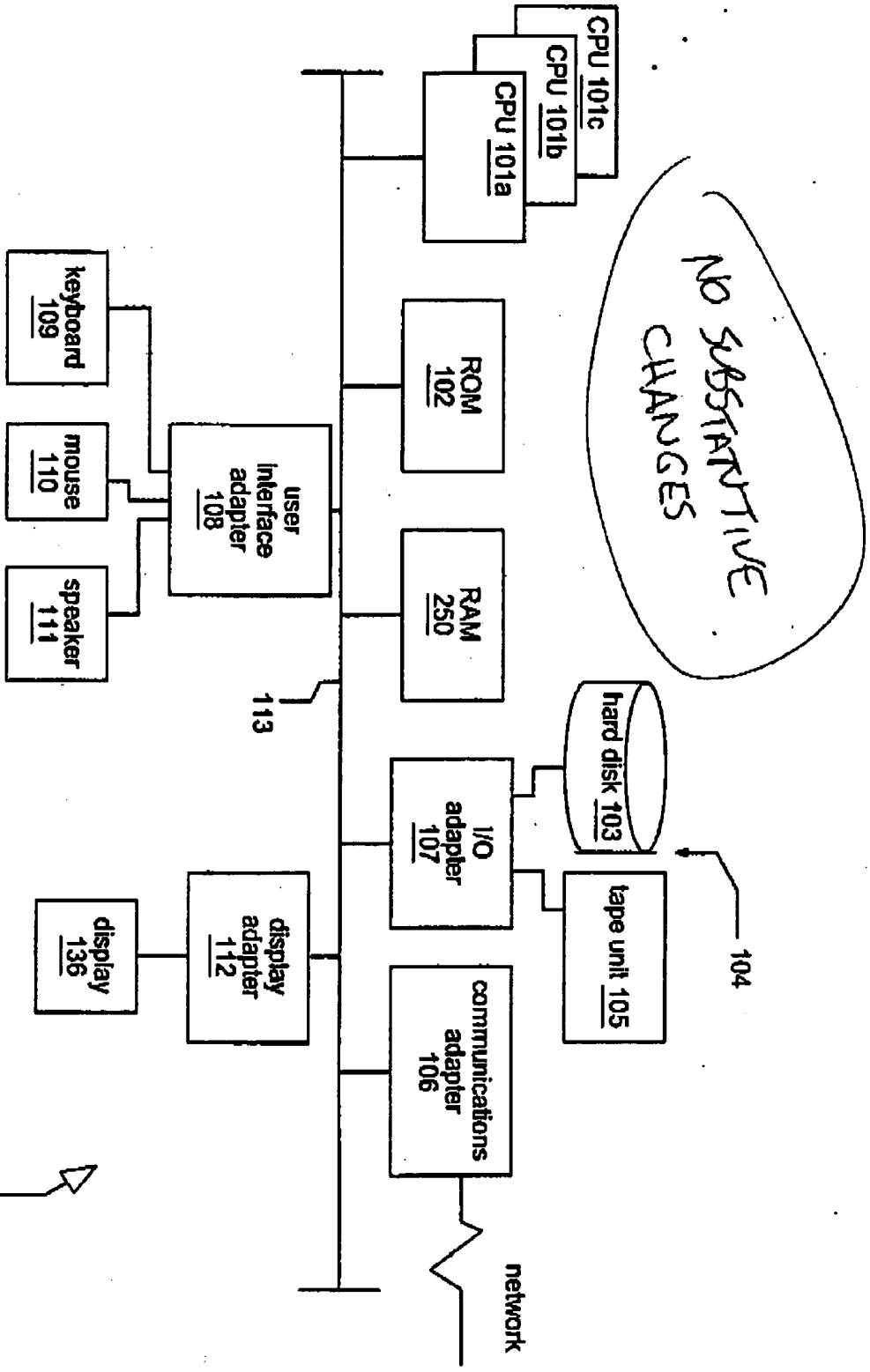

FIG. 1

Annotated Sheet Showing Changes

```
          LD R1, MEM(EA1)
          LD R2, MEM(EA2)
IA1       CMP R1, R2
IA2       BC LBL1
IA3         INST A
IA4         INST B
IA5         INST C
IA6       BR LBL2
     LBL1,
IA7         INST D
IA8         INST E
IA9         INST F
    LBL2,
IA10      ETC
```

FIG. 3
PRIOR ART

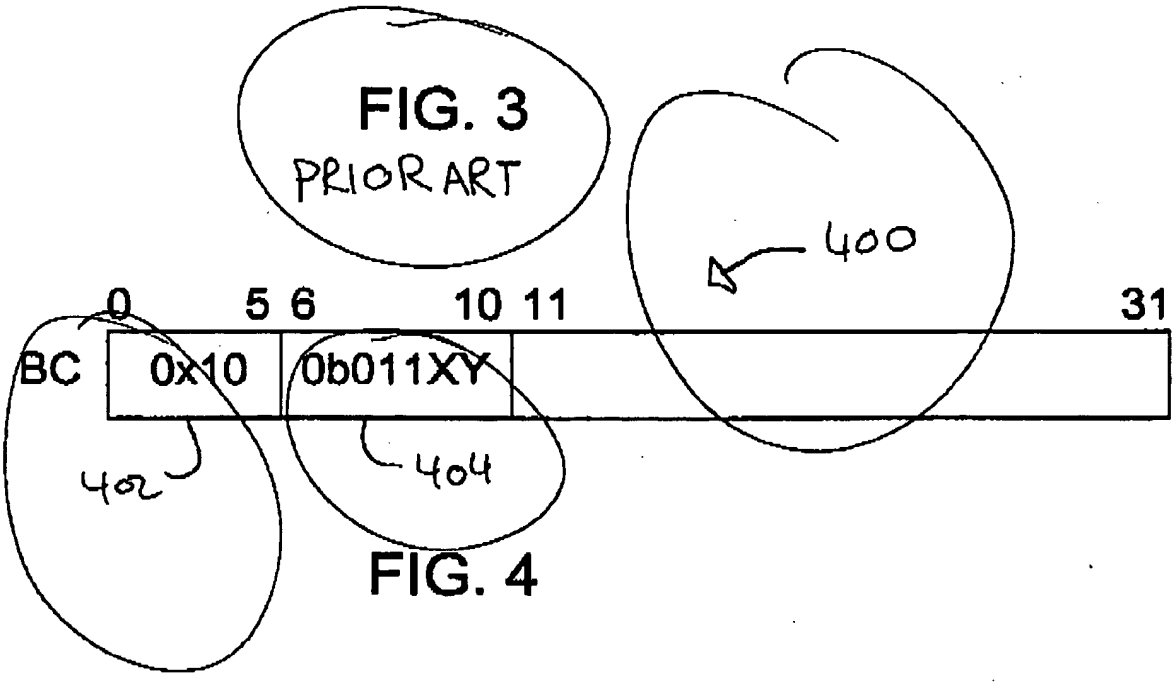

FIG. 4

Applicant: Kahle and Moore
Docket: AT9-99-445
Sheet 2 of 4
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Annotated Sheet Showing Changes

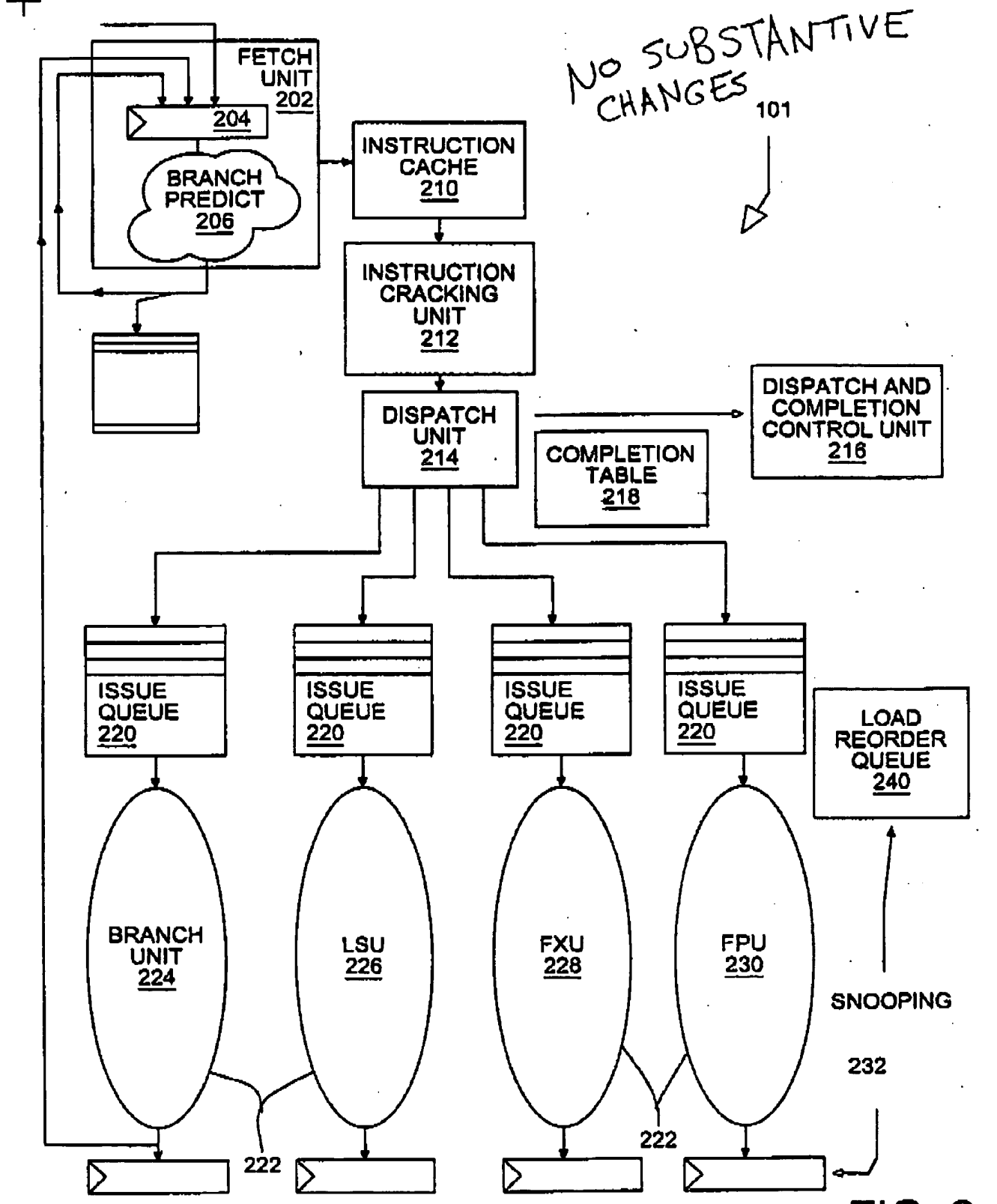

FIG. 2

Applicant: Kahle and Moore
Docket: AT9-98-445
Sheet 4 of 4
Contact J. Lally 512/428-9870

Annotated Sheet Showing Changes

NO SUBSTANTIVE CHANGES

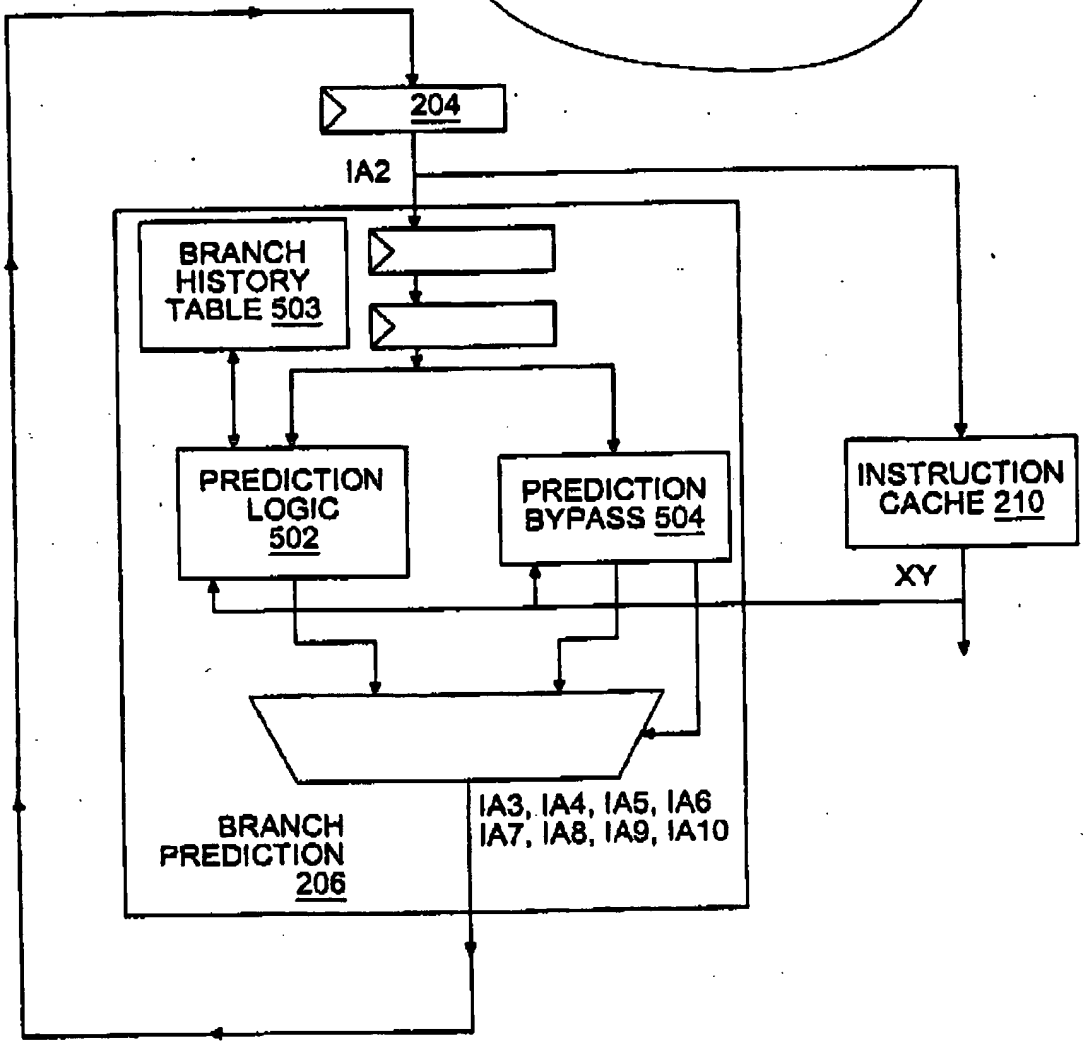

FIG. 5